Bronchopleural Fistula and Empyema After Anatomic Lung Resection

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KEYWORDS

• Empyema • Bronchopleural fistula • Eloesser flap • Decortication • Clagett procedure

KEY POINTS

- Bronchopleural fistula (BPF) and empyema remain rare but serious complications after anatomic lung resection, particularly pneumonectomy.
- Careful attention to identified risk factors and proper surgical technique can minimize the risk of BPF/empyema in most cases.
- Management of BPF/empyema after surgical resection must address both issues of bronchial integrity and the infected plural space for a successful outcome.
- After pneumonectomy, resolution may require multiple, additional surgical interventions.

Empyema after anatomic pulmonary resection remains a rare but serious complication, often leading to major morbidity and increased mortality. In a modern series of 1023 patients undergoing anatomic resection, empyema occurred postoperatively in 1.1%.[1] It occurs more commonly after pneumonectomy, particularly after surgery for benign disease.[2] The reported incidence of depends in part on the postoperative surveillance protocols and diagnostic techniques used.[3,4] The associated mortality rate may exceed 10%[5]; even if the patient survives, the recurrence rate of infection can be as high as 38%.[6] Importantly, up to 80% of cases of procedure-related empyemas are associated with bronchopleural fistula (BPF)[4] and fewer than 20% of these can be expected to close spontaneously.[7] The presence or absence of BPF in the setting of postoperative pleural empyema defines 2 clinical cohorts that are distinct with respect to etiology, risk factors, and treatment algorithm.

ETIOLOGY, RISK FACTORS, AND PREVENTION

A BPF may arise either from dehiscence or disruption of a bronchial closure after anatomic lung resection (segmentectomy, lobectomy, pneumonectomy), or from anastomotic dehiscence after bronchoplastic resection. Postoperative BPF is classified based on the time of onset after surgery as early (within the first week), intermediate (between 7 and 30 days), and late (after 30 days).[8]

There are a number of predisposing factors that may place the patient at increased risk of developing a fistula and subsequent empyema. Malnutrition, various immunosuppressive therapies (steroids, antimetabolites), prior thoracic radiation therapy, poorly controlled pulmonary or pleural infection, active smokers, and the use of induction chemotherapy have all been implicated in the development of fistula. Interestingly, induction therapy has been cited as a risk factor after pneumonectomy,[9] but not after bronchoplastic procedures.[10–12]

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Early fistulas are most commonly owing to surgical technical problems. It is well-established that right pneumonectomy is associated with a greater risk (up to 13.2%) of BPF compared with left pneumonectomy (up to 5.0%).[13] There are 2 main reasons accounting for this; first, the most common anatomic variant of bronchial arterial supply is composed of 1 artery on the right, whereas a dual arterial supply is the most common configuration on the left. Second, the left main stem bronchus is protected under the aortic arch and surrounded by its vascularized mediastinal tissue, whereas the right bronchial stump has no such coverage. Overzealous mediastinal lymphadenectomy,[14] bronchial stump greater than 25 mm in diameter,[15] long bronchial stump, residual malignancy at the bronchial margin,[5] requirement for 4 or more units of intraoperative packed red blood cell transfusions,[3] completion pneumonectomy,[3] and tension along the anastomosis are associated with stump ischemia and are well-described risk factors for early failure. Stapler misfiring, improper tissue apposition, or poorly secured sutures are also common technical causes of early bronchial anastomotic breakdown.

Postoperatively, the main risk factor for BPF is positive pressure mechanical ventilation[16]; for this reason, extubation at the end of the case is typically a priority.

Late fistulas are typically secondary to patient-related factors causing poor healing: age greater than 60 years, malnutrition, ongoing pulmonary or pleural infection, and recurrence of malignancy.

Empyema after anatomic lung resection in absence of BPF is most commonly caused by intraoperative contamination by aerobic bacteria. Zaheer and colleagues[17] and Eerola and associates[18] found that *Staphylococcus aureus* is the most common organism isolated, followed by *Streptococcus pneumoniae*. Spillage of infected bronchial secretions, active plural infection at the time of surgery, and esophagopleural or gastropleural fistulas are the most common causes. Less frequently, a primary infection of pleural space, because it may occur after chest trauma with chest wall penetration or hemothorax and mycobacterial infection of the pleural cavity,[19] may lead to bronchial stump breakdown. There is scant evidence that hematogenous infection of the pleural space can occur from a distant infection site (classically osteomyelitis) without an intermediate lung infection, which in turn contaminates the pleural cavity.[20]

PATHOLOGY

It is worth reviewing the classic time course and stages of empyema development.[21] In stage 1 (exudative, acute), exudative fluid is present, the visceral pleural remains elastic and the dimensions of the chest cavity are maintained. Stage 2 (fibrinopurulent, subacute) is characterized by the presence of infected or frankly purulent fluid, and fibrin deposition creates septations and loculations within the pleural cavity. Lung compliance may also be reduced owing to thick fibrin depositions. In stage 3 (consolidative, chronic), granulation tissue formally replaces the pleural space, and the lung becomes completely entrapped by a fibrinous peel. Late in the course, organization of the inflammatory tissue causes contraction of the affected hemithorax with ipsilateral shift of the mediastinum, elevation of the diaphragm, and narrowing of intercostal spaces.

This time course, characteristic of a common or postpneumonic empyema, is usually altered by the postoperative medical attention these patients receive, particularly with the presence of a BPF. It is imperative that the treating surgeon be acquainted with the often subtle symptoms and signs that can lead to early diagnosis and treatment.

CLINICAL PRESENTATION AND DIAGNOSIS

Postoperative empyema of the pleural space is associated with a constellation of signs and symptoms that are dictated mainly by the presence of an infected pleural cavity and a BPF. If a BPF has indeed opened, its size and timing of formation are major determinants of the clinical picture. The duration of illness is also an important determinant of the clinical manifestations.

Minor fistulae may be occult or minimally symptomatic and are usually detected if a postoperative bronchoscopic screening for BPF is performed routinely.[22] A persistent (>7 days) air leak, especially if brisk, without a history of visceral pleural dissection or injury at the time of surgery, new evidence of pneumomediastinum, a decrease in the fluid level in the ipsilateral pleural cavity, or a new air–fluid level (“meniscus sign”) at the height of the bronchial stump on chest imaging after lung resection should raise the suspicion for BPF (**Fig. 1**). In cases where the BPF is larger than a few millimeters, respiratory distress may be a prominent finding and is caused by either spillage of pleural fluid through the fistula into the contralateral lung or by “dead space” ventilation into the empty pleural space. Worsening dyspnea and productive cough with frothy or purulent sputum herald the loss of integrity of the bronchial closure. Expectoration typically worsens with the patient lying on the side opposite to the one involving the fistula. The flooding of the contralateral lung may lead to, if not overt pneumonia, an alveolar